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(71) Applicant(s)
Yousri Mohammad Taher Haj-Yousef
PO BOX 29180, Sharjah, United Arab Emirates

(72) Inventor(s)
Yousri Mohammad Taher Haj-Yousef

(74) Agent and/or Address for Service
Urquhart-Dykes & Lord
(Home Counties), 1 Richfield Place, Richfield Avenue, READING, Berks, RG1 8EQ, United Kingdom

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(54) Abstract Title
Method and device for detecting movement of objects and/or fluid flow

(57) Detection of visible or concealed moving objects and/or fluid flow by means of tracking the RF impedance variation of a stable media which contains the targeted moving object/fluid. An RF transmitter is connected to an antenna surrounding the media to be monitored and tuner means matches the impedance of the antenna to the load impedance of the monitored media. Movement of an object/fluid within the monitored media causes a change in the load impedance presented to the antenna. Processor means process forward and/or reflected RF radiation signals from the antenna to provide an output signal representative of changes to the load impedance which indicates movement. The movement detection means can be used in agricultural, medical, security and traffic monitoring applications.

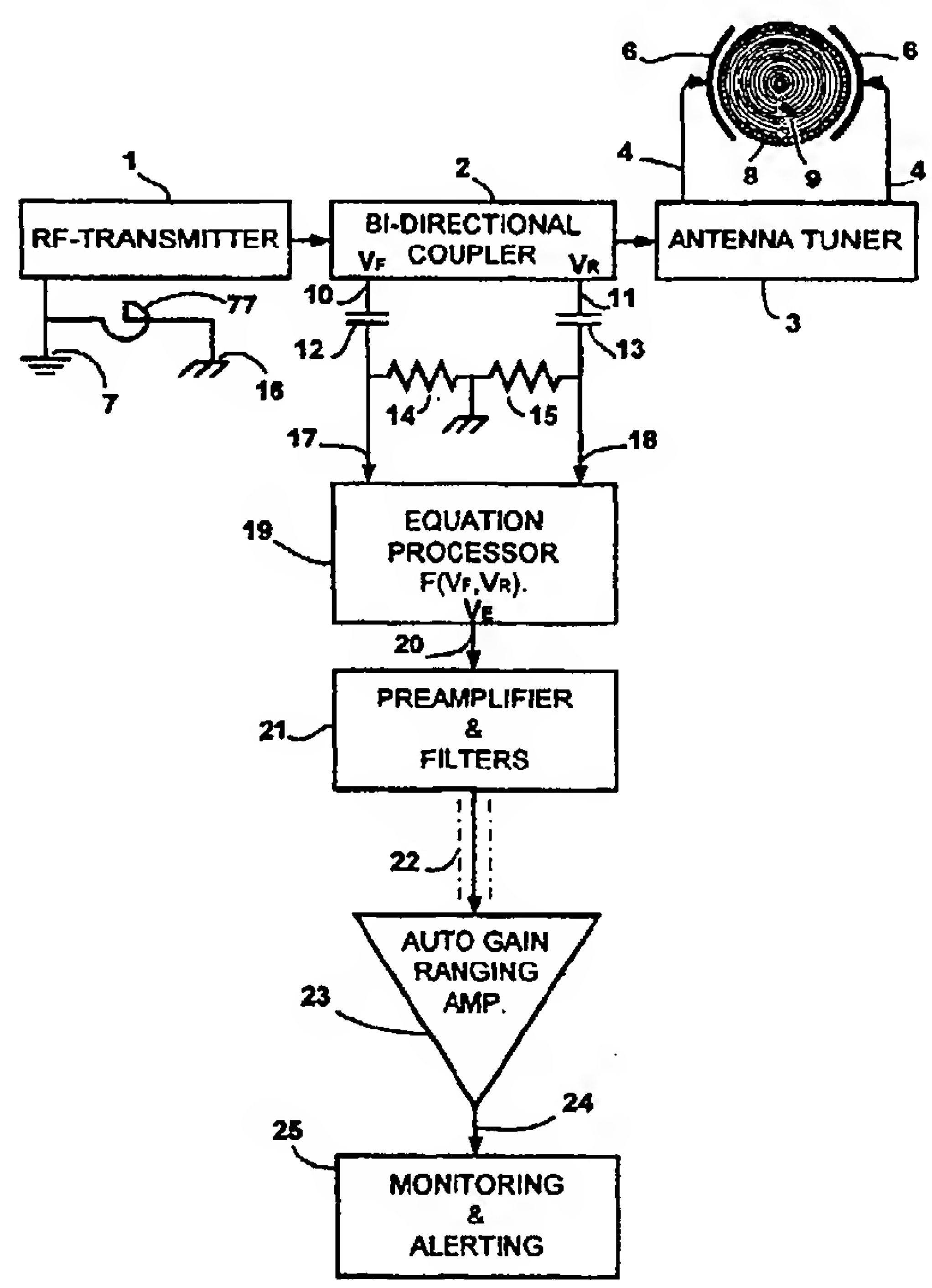

FIG. 1

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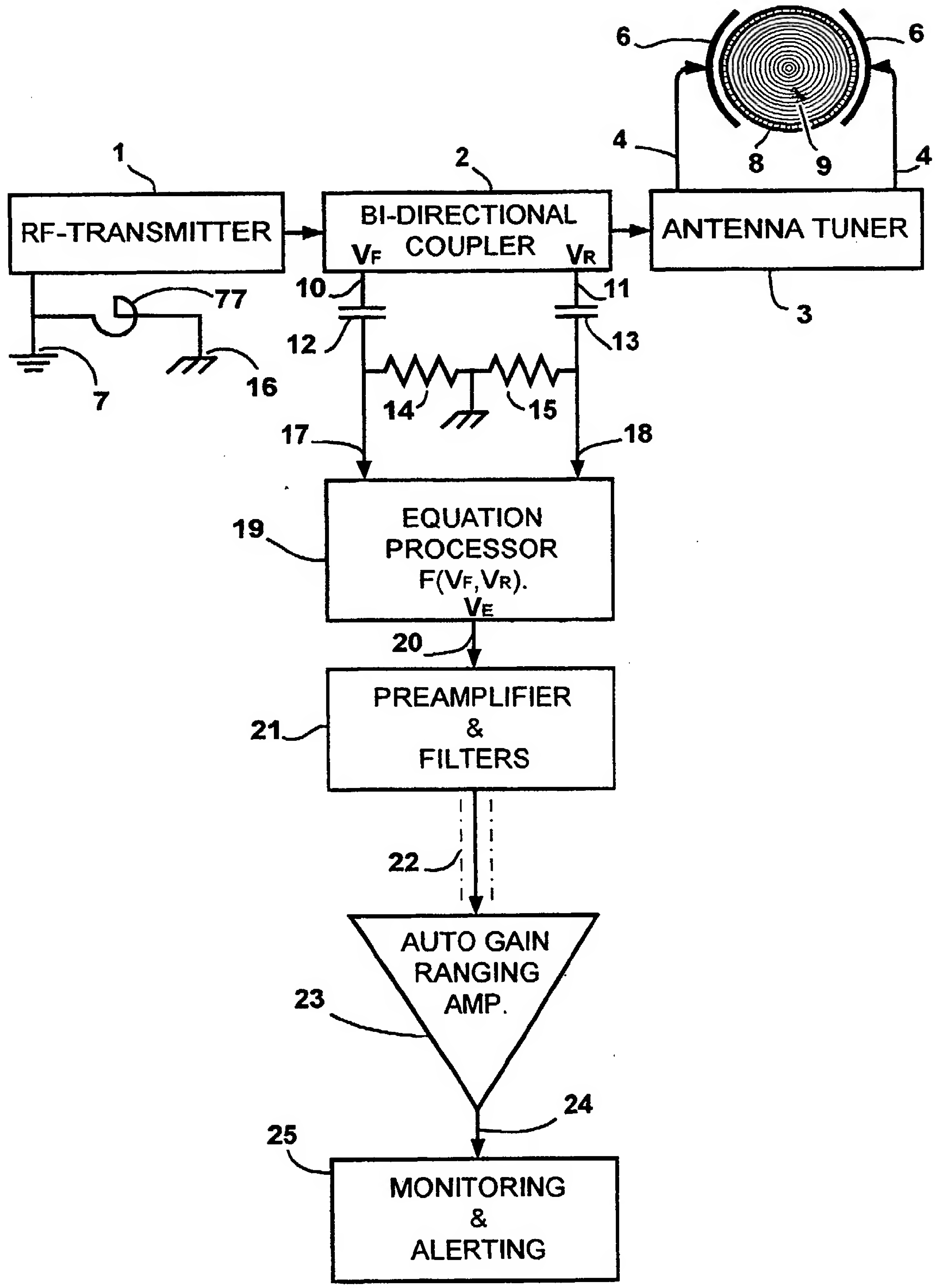
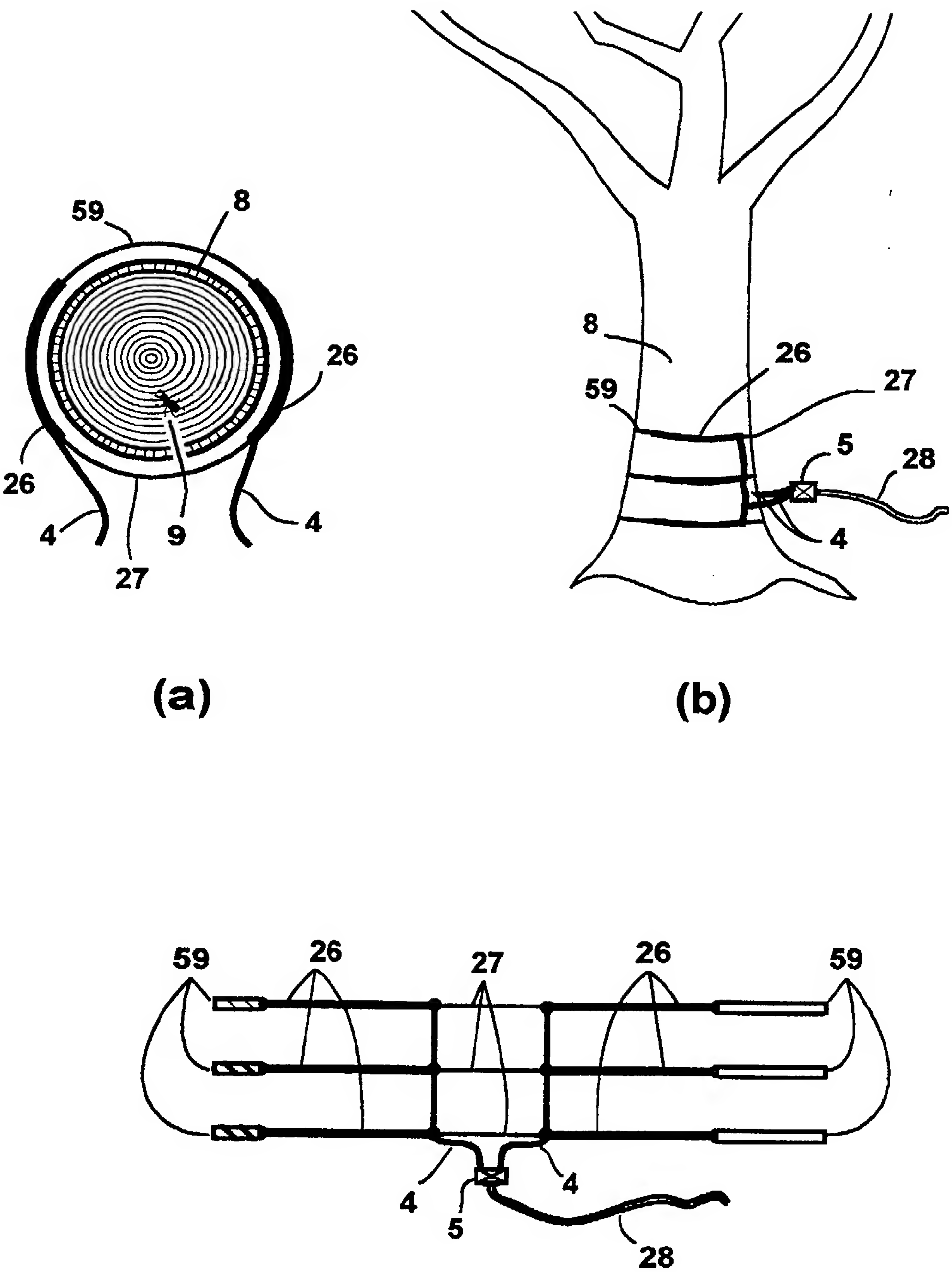


1
RF-TRANSMITTER
2
BI-DIRECTIONAL COUPLER
VF
VR
ANTENNA TUNER
3
4
4
6
6
8
9
10
11
12
13
14
15
16
7
77
17
18
EQUATION PROCESSOR
F(VF,VR).
VE
19
20
PREAMPLIFIER & FILTERS
21
22
AUTO GAIN RANGING AMP.
23
24
25
MONITORING & ALERTING

FIG. 1



(a) (b) (c)

FIG. 2

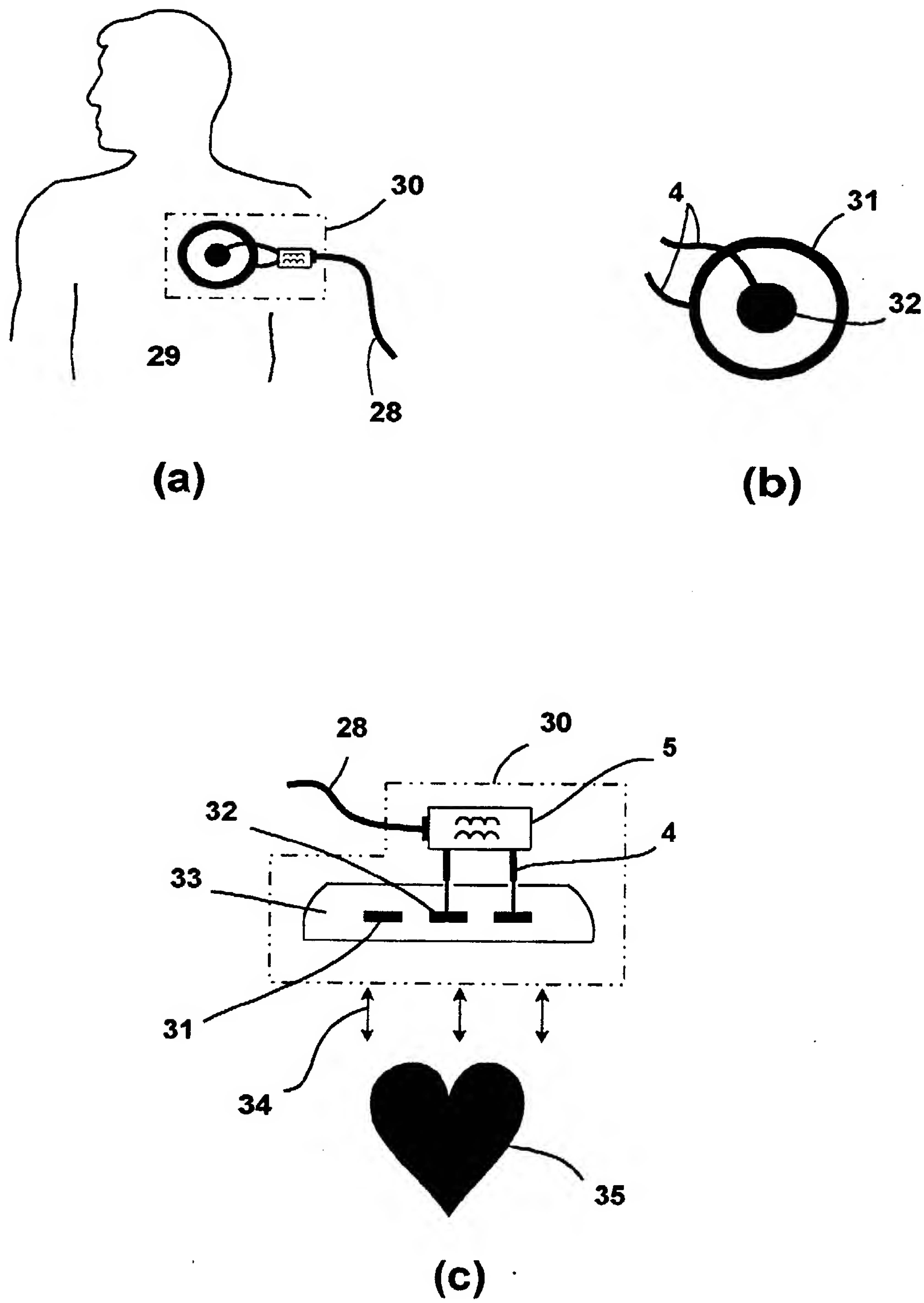
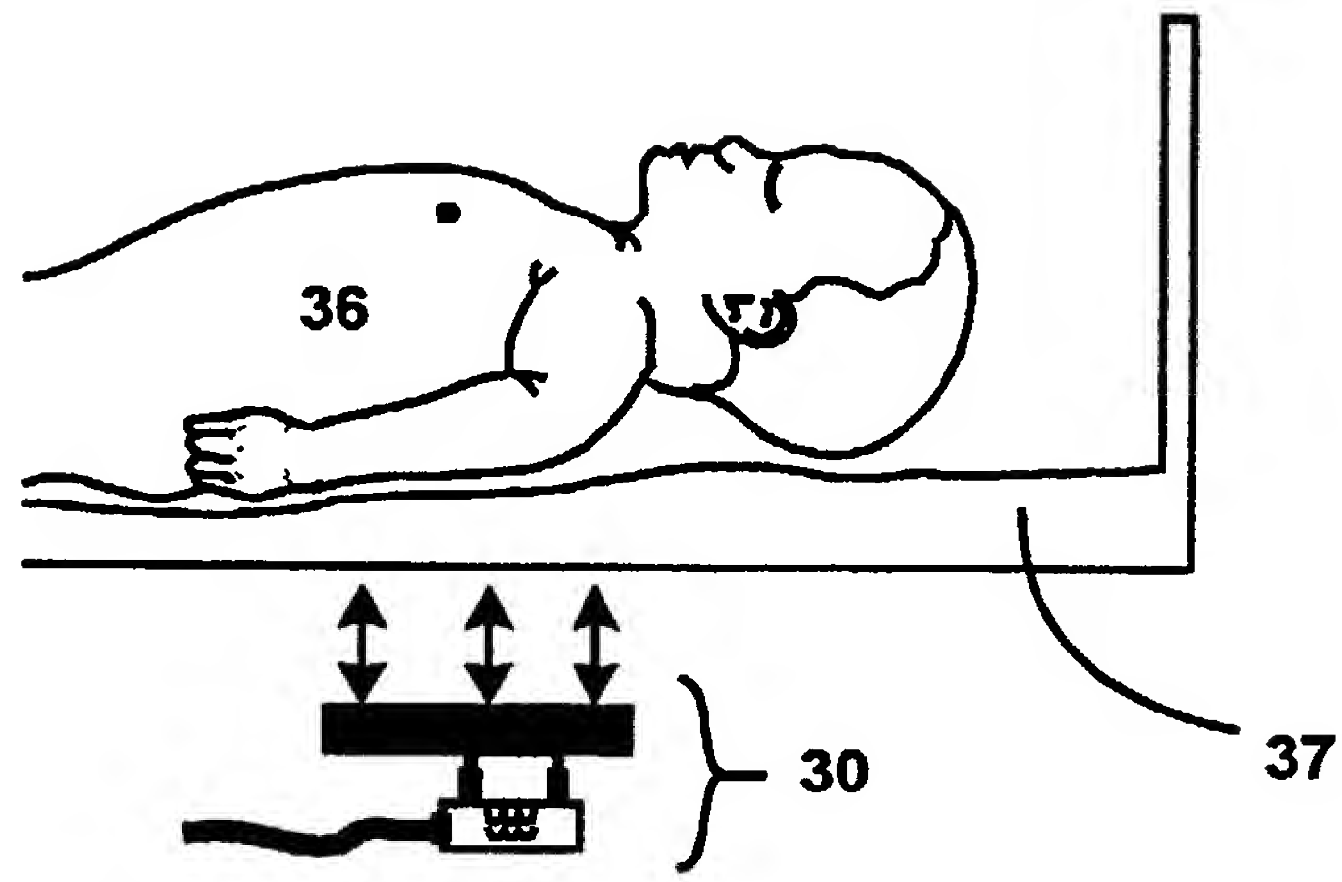
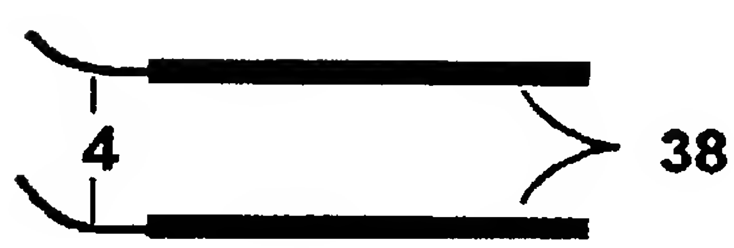


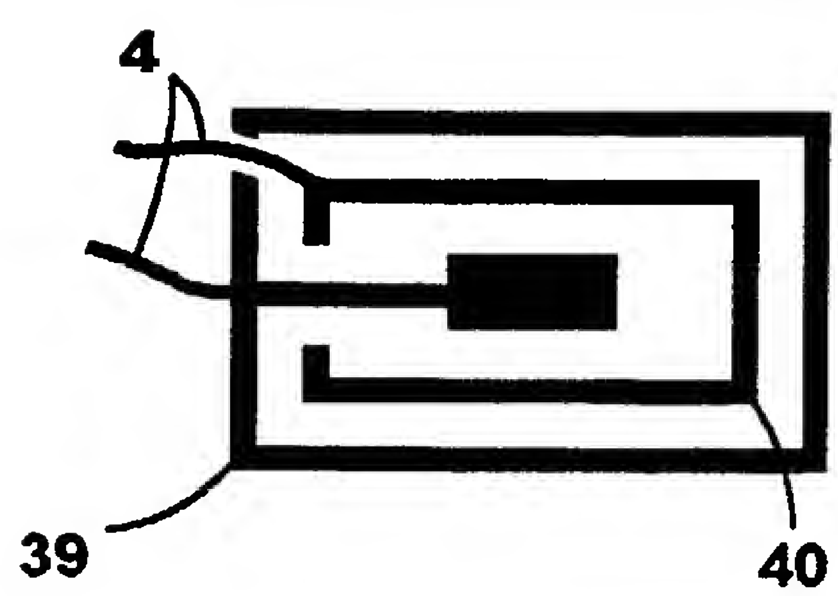
FIG.3



(a)



(b)



(c)

FIG.4

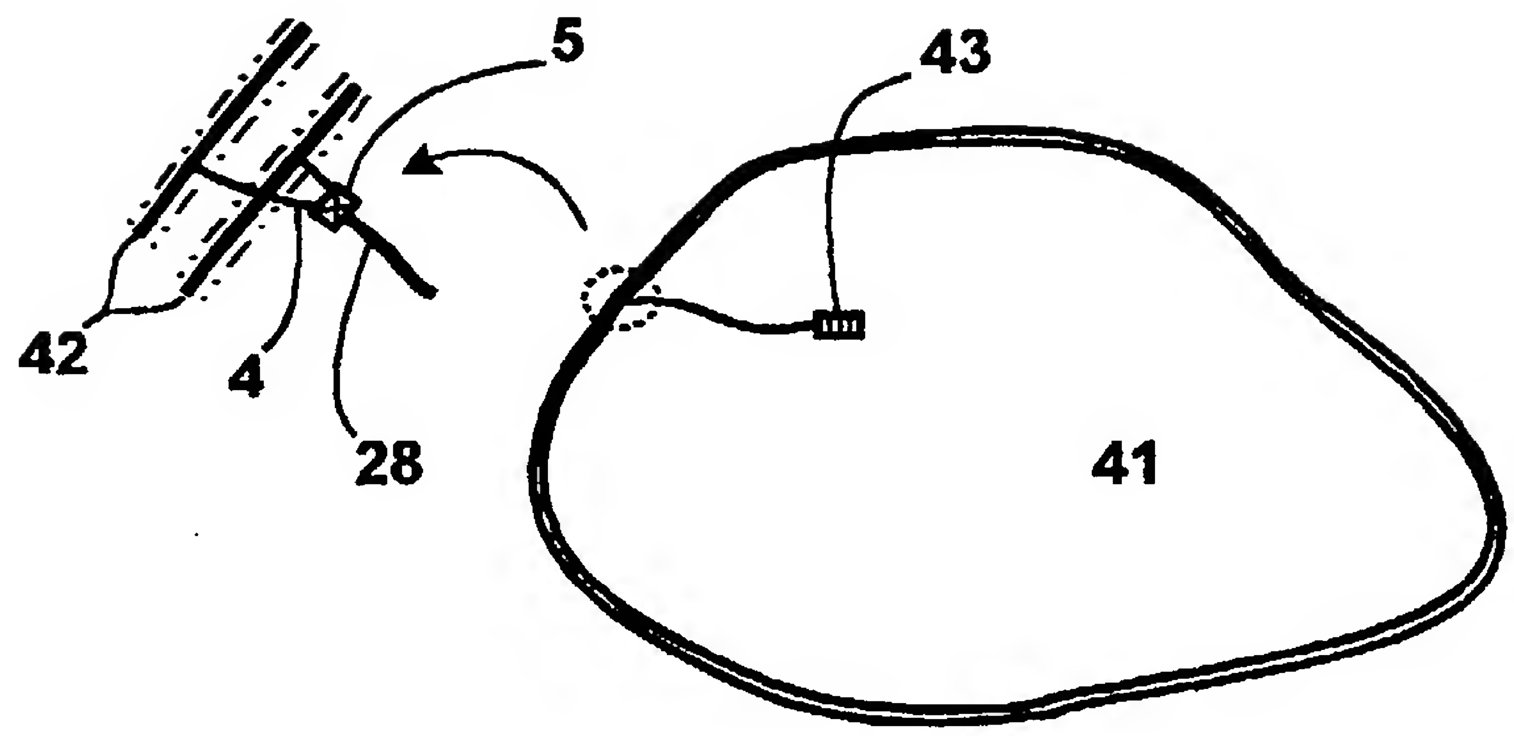


FIG. 5

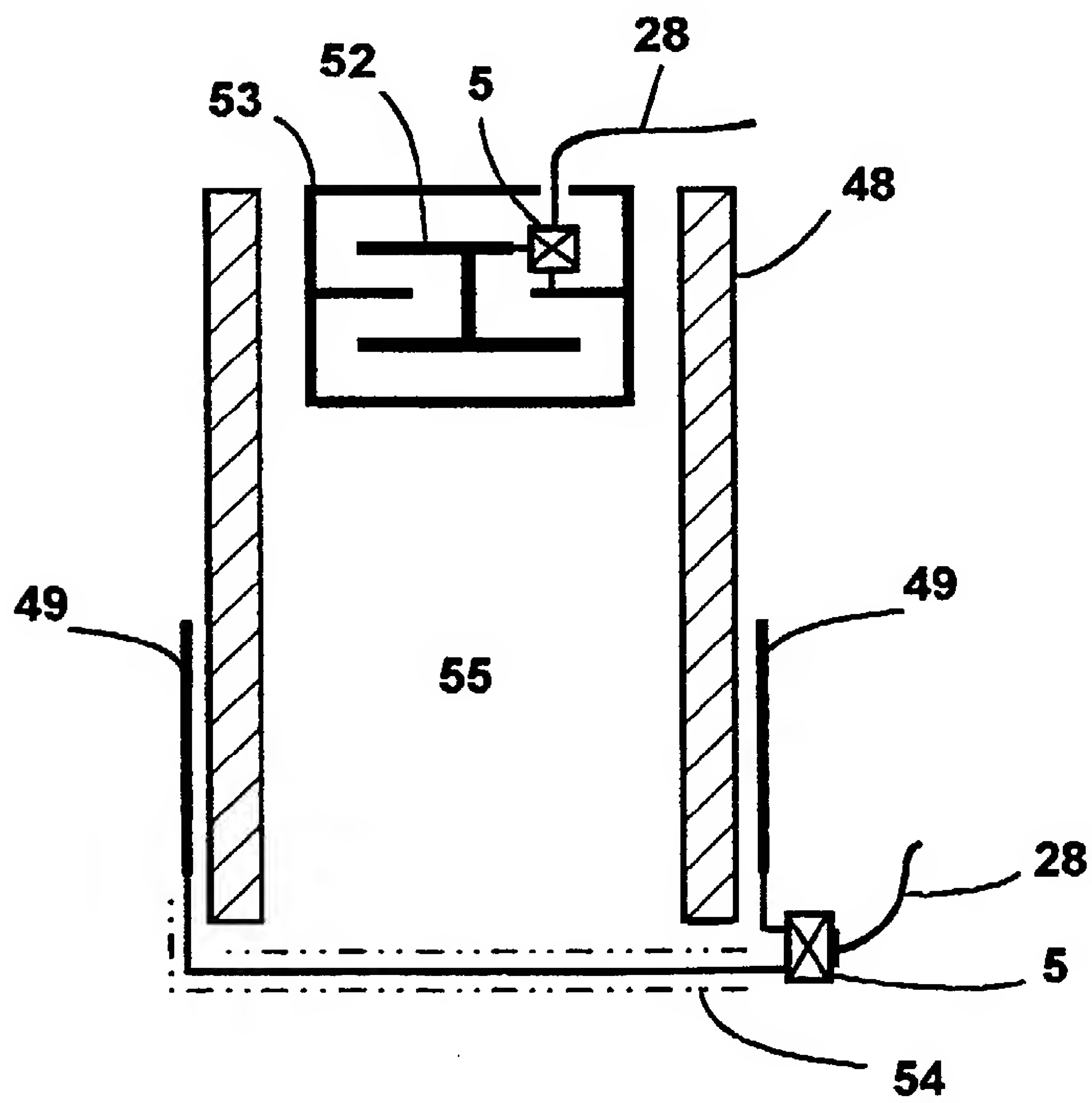


FIG. 6

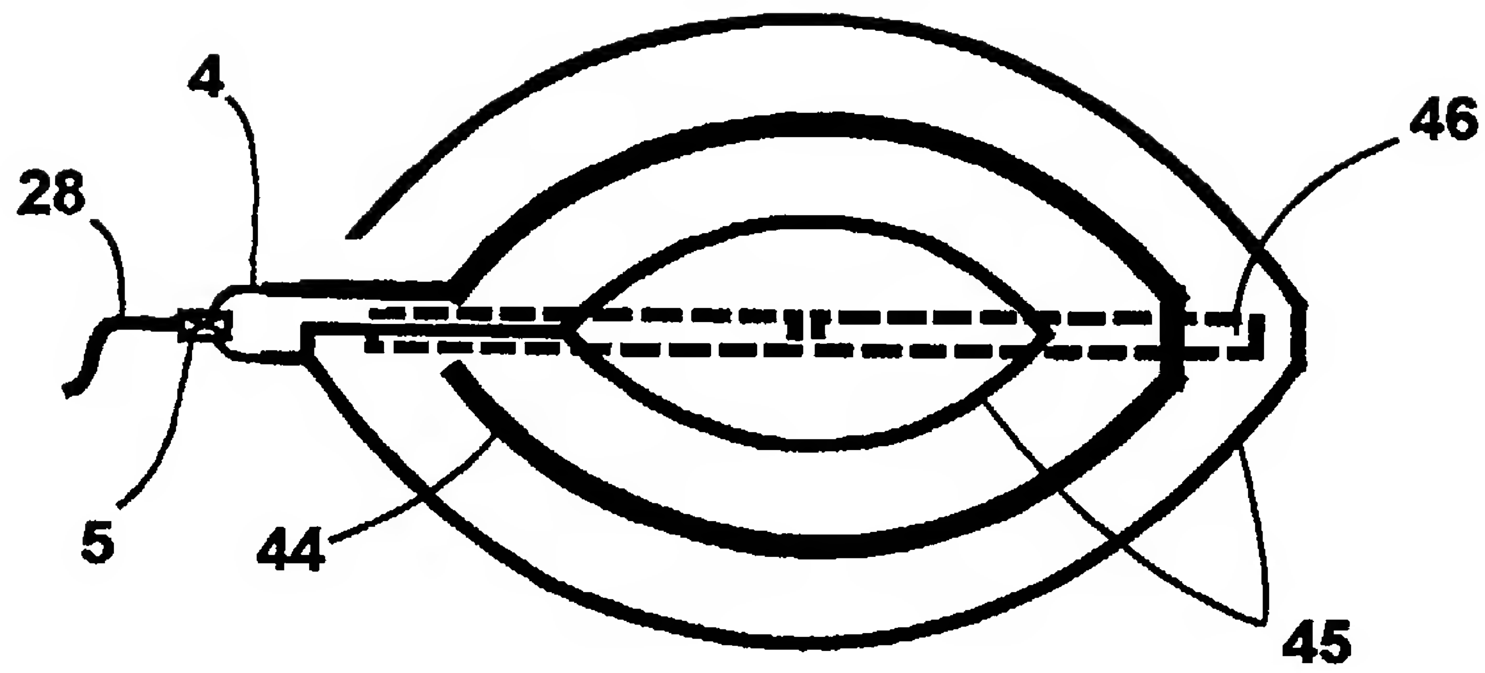


FIG. 7

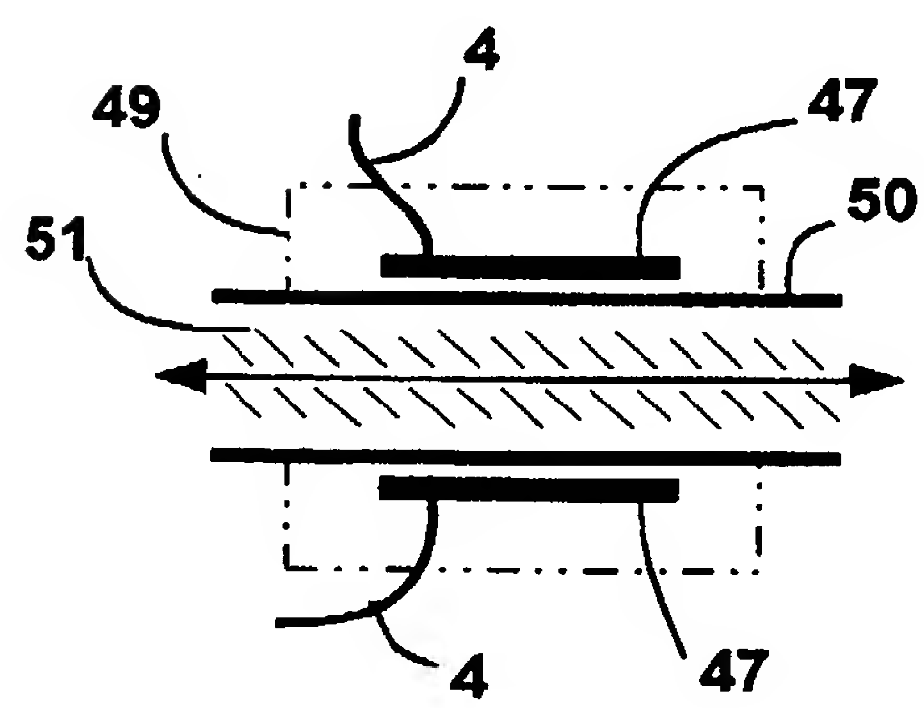


FIG. 8

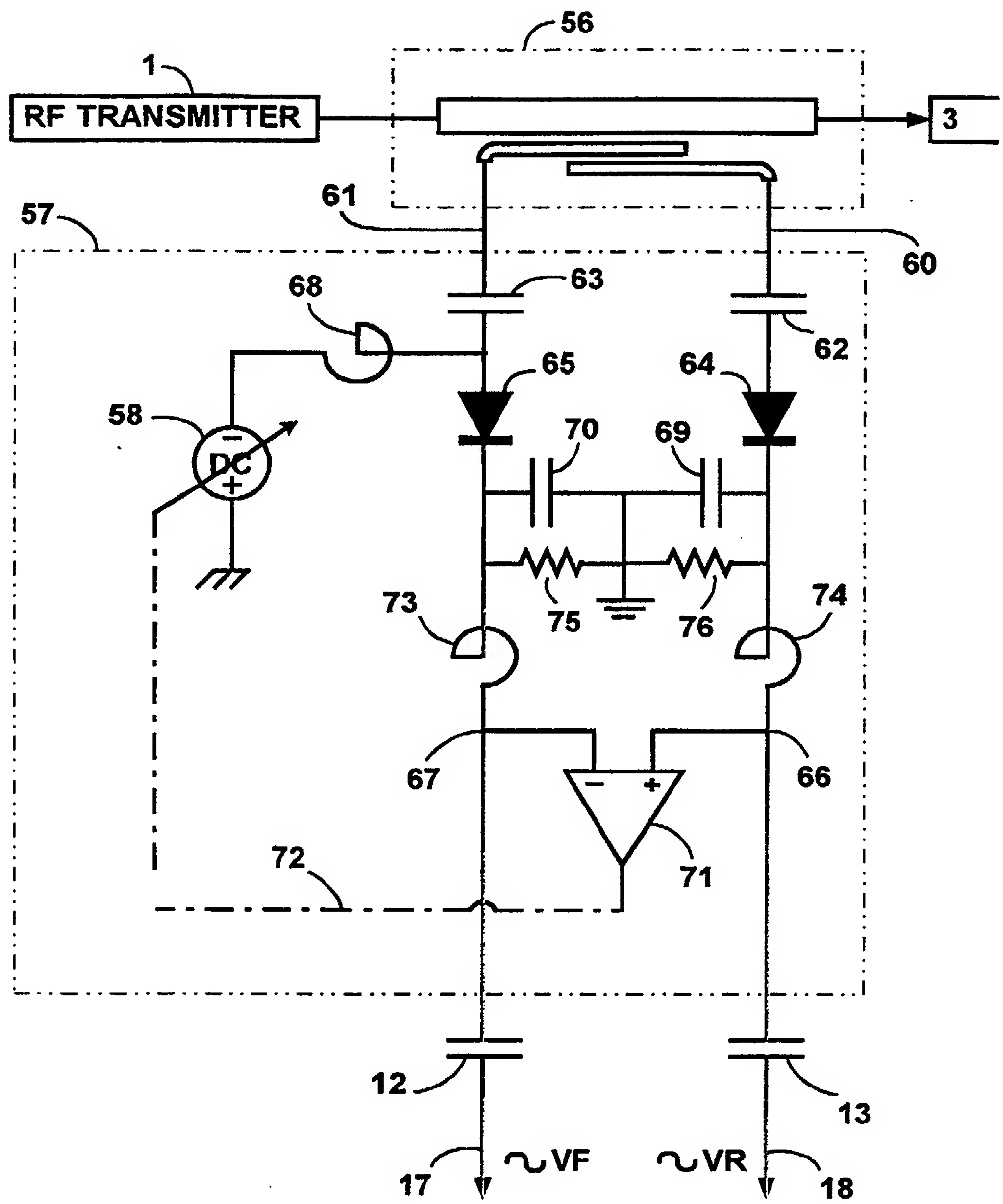

56
1
RF TRANSMITTER
3
61
57
60
63
68
62
65
64
58
DC
70
69
75
76
73
74
67
66
72
71
12
13
17
~VF
~VR
18

FIG. 9

A METHOD AND A DEVICE FOR DETECTING AND MONITORING CONCEALED BODIES AND OBJECTS

The presented invention, which has a multi-application usage, generally pertains to a method for remote sensing of visible and invisible moving bodies or objects, even those hidden in immune barriers and concealed locations.

Detection of movement occurs by tracking any variation in the RF impedance of a stable media in which the targeted object is located. ("Media" in the context of these documents will mean the environment close to the moving body or object under inspection. "Targeted object" will mean the moving body or object under inspection).

A stable power electro magnetic (EM) field, at a fixed frequency (high range), is created around the targeted object. By extracting the slight power changes from the resultant forward and reflected powers inside the transmitting line, which transfers and carries the transmitted EM energy, any movement of the targeted object within the media can be detected.

By way of example, and not of limitation, the method of the present invention comprises usage in the following applications:

1. In the agricultural field by a device for detection of early infestation by red palm weevil and tunnel borers in tree trunks and upper roots. This application is particularly important where the insect larvae secretly and silently consumes the tree's core, producing tunnels and hollows which leads to the death of the tree. Detection of early infestation is vital but extremely difficult, and by the time the evidence of presence of the pest becomes apparent it is too late to save the tree. Unless the infestation is detected and treated at early stage the life of the tree is limited to a few months.

Present research indicates that this pest seriously threatens untold millions of palm and fruit trees all over the world and unless this problem is effectively resolved very soon, the likelihood is that all trees in afflicted areas will die within a few years.

2. In the medical field, this method can be implemented in various applications, such as a device for real time monitoring of the heart's motion (kinetocardiograph). There is no direct contact of device circuits to the human body. Data drawn from this method will add new parameters in the field of medicine for more versatile and comprehensive diagnosis of heart problems.

The principle present day methods for heart monitoring are:

- Electrocardiograph (ECG) which monitors the heart activity by tracking the electrical signals generated by the chemical reaction of the heart muscles. This method employs the use of electrodes directly attached to the patient.

- Phonocardiogragh (PCG) which indicates audibly the heart motion. This method involves the use of a microphone directly on to the patient.

- Dopplercardiograph (DCG) monitors the heart activity using the ultrasound Doppler effect. This method employs the use of an ultrasound probe in contact with the patient's body under specific conditions.

All of the foregoing methods are measuring reaction of the heart's motion, and all require direct contact with the patient by electrodes etc.

The presented invention, has the following advantages by monitoring the heart:

One) In real time.

Two) directly without dependence on reaction.

Three) does not require any direct contact with the patient.

Four) monitors the motion activity of "all" the components of the heart.

3. Additionally the method can also be used as a device for continuous monitoring of newborn, premature babies, and patients under intensive care. All the present day methods require direct contact with the patient / baby either in the form of contact electrodes, or pressure sensor mattresses. They are impractical in the case of premature babies due to the frequent requirement to move the baby for feeding, cleaning, etc.

The device can also be utilised to give an early alarm, whenever a life-threatening situation arises such as arrest or sudden death threat, by continuous and precise remote monitoring of the movement of vital organs such as lungs in the breathing process. This will accelerate emergency intensive care.

Since the device is monitoring the organ activity remotely it does not require attachment of electrodes etc to the body. The data drawn from this device can also be collated for analytical evaluation for diagnostic purposes.

4. This method also will be used to detect sudden instability in flow of liquids, for example blood through tubes and vessels in open heart surgery and dialysis treatment, by remotely sensing the flow intensity of the liquid.

This new method will provide a mechanism to monitor and sense the slightest unexpected change in flow process. This will guarantee for example, not to have any air bubble leakage into blood path, and at the same time protecting it from thrombosis and contamination since this is done by remote sensing without any direct contact.

5. Another application will be in concealed security systems for protection against thieves and intruders, through sensing body movements in corridors or regions, which need protection. The sensors can be hidden underground or inside or behind walls, even cement ones, so that they can not be located and disabled by intruders.

6. Automatic access control is also an area where the method will be effectively used, since most existing automatic outdoor control systems are affected by light/darkness, dust, heat, etc.

Another example is to monitor and control traffic and traffic signals, by sensing vehicle movements in road traffic activity.

From the necessarily limited examples given above it will be seen that the method has a very wide spectrum of applications.

It is an established fact that the optimum transfer of (EM) energy from a radio frequency (RF) transmitter to the load, occurs when the output impedance of the transmitter matches the load impedance.

The popular method used to predict the match level is achieved by sampling the actual values of the forward and reflected powers. These values can be easily picked up by passing the transmitted RF power through a bi-directional coupler. The picked up power values are represented by the bi-directional coupler in voltage form, so the presented values will be the forward V_F and reflected V_R voltages.

The measured V_F and V_R are then combined together by special equations (mathematical formulas) to produce a nominal calculated value. This value will reflect in one way or another the real match level.

Voltage Standing Wave Ratio (**VSWR**) is the most common expression, to indicate the degree of match:

$$\mathbf{VSWR} = (V_F+V_R) / (V_F-V_R)$$

Also there are other widely used expressions, which demonstrate the actual match level. These expressions are the reflection coefficient (ρ), and the return loose coefficient, and many more.

When a stable power RF generator is used to transmit EM energy at a stable load (media), and where the RF generator output impedance and the load impedance have nearly the same value, then the resulting level of match will also be stable. When the load (media) or a part of it moves within the transmitted EM field, then the resultant impedance for the load will vary positively or negatively. This move will also vary the match level, according to how the match or mismatch occurs.

Similar phenomena can be easily seen in real life, where there is a change in clarity of TV picture quality when there is human movement near to the internal TV antenna. Such movement leads to deviation in the impedance match between the TV input and the antenna. This is because the human body has complex parasitic impedance, which affects the resultant antenna impedance value. Such variation in the impedance match will affect the power level of the RF signal picked up by the TV tuner.

Normally the TV antenna has 300-Ohm standard impedance, which is stepped down by a 4 to 1 ratio transformer, so as to match the 75-Ohm TV input impedance.

By the exploitation of the above phenomena, it is possible to detect the movement of bodies or objects even if they are located in concealed non-metallic or partially metallic locations.

The proposed invention as an example can be used to detect the infestation by stem borers, which attacks deeply inside the tree trunk. This can be achieved through creating a stable EM field by encircling the tree trunk with the transmitting antenna.

Then the complex impedance structure of the tree trunk matches the transmitter output impedance through a matching network. The EM energy passes through a bi-directional coupler, which produces the **V_F** and **V_R** signals.

By the use of DC blocking capacitors (high pass filters - HPF) the variable values which indicates the movement parts of the load from the resultant **V_F** and **V_R** will pass only through these capacitors.

These quite small variable signals are then directed to a linear circuit called an equation processor, which combines both variable signals by utilising the selected equation, e.g. loose coefficient (**V_R/V_F**) or others.

The output signal from the equation processor then can be greatly amplified to a level where it can drive a visual or audio alarming indicator. The same general method described above can similarly be implemented to achieve all the applications aforementioned.

The invention may be further understood by reference to the accompanying drawing, in which:

Fig. 1 shows the general block diagram of the preferred embodiment of the invention.

Fig. 2 shows an embodiment of the invention in the agriculture field, for detecting the infestation by red palm weevil and stem borers, hidden deeply within the tree trunk or the upper roots. (**a**) Shows a cross section top view of the tree trunk surrounded by the transmitting antenna assembly. (**b**) The side view. (**c**) The components of the preferred transmitting antennas assembly.

Fig. 3 shows an embodiment of the invention for use in the medical field, for monitoring the motions of the human heart (kinetocardiograph). (**a**) Shows the preferred position of the patient antenna, which can be placed in front or back of the patient. Also two electrodes or metal sheets can be used as an antenna, to surround the human chest (heart side), one from the back, another one from the front. (**b**) Shows a top view of the overlapped conductors used as transmitting antenna. (**c**) Illustrates the assembly details of the preferred transmitting antenna.

Fig. 4 shows another embodiment of the invention in the medical field, for early detection of threat of sudden death in premature or newborn babies. (**a**) Shows the position of the transmitting assembly, which could be placed on the underside of the baby's bed or the infant incubator. The transmitter block used here is similar to the one used in **fig. 3**. In (**b**) and (**c**) are shown another two alternatives arrangements for the transmitting antenna.

Fig. 5 shows an embodiment of the inventions in a security system. Here two parallel-insulated wires **42** are positioned underground are used to encircle the landscape **41** under scrutiny.

Fig. 6 shows another embodiment of the invention in security applications for the use in closed areas like in corridors **55**. The transmitting antennas can be placed underground **52, 53**, or behind **49** the walls **48**.

Fig. 7 shows an embodiment of the invention in the automatic access control. Such an arrangement can be used to control sliding doors **46.** To eliminate the interference, which will occur due to the natural automatic door closing process, doors can be made from non-metallic material. Alternatively the door closing speed can be adjusted to be outside of the device responding bandwidth.

Fig. 8 shows an embodiment of the invention for sensing any fluctuation in the flow of liquids **51** in non-metallic tubes or piping **55**.

Fig. 9 illustrates a general block diagram for achieving a good level of linear symmetry for the rectifier diodes of the bi-directional coupler. The RF pickup coils **56** samples the basic **V_F** and **V_R** HF voltages, then the pickup signals pass to the demodulator (rectifying) stage **57**. The difference amplifier **71** produces a signal to control the source of the negative DC voltage **58** until the output voltage of the difference amplifier **72** reaches zero.

In the drawings:

[1] is a RF transmitter

[2] is a bi-directional coupler

[3] is an antenna tuner (matching network)

[4] is an output transmission line

[5] is an un-balanced to balanced transformer

[6, 26, 31, 32, 38, 39, 40, 42, 44, 45, 47, 49, 52, 53] are various types of transmitting antennas

[7, 16] are RF and linear grounds respectively

[8] is a suspected tree trunk

[9] is a targeted pest

[10, 11] are forward **VF** and reflected **VR** voltages respectively

[12,14 and 13,15] are the RC high pass filters (HPF)

[17, 18] are the extracted variable signals from the basic **VF** and **VR** voltages

[19] is an equation processor block

[20] is an O/P signal **VE** from the equation processor block

[21] is a preamplifier and filter circuit

[22] is a signal carrier extension cable

[23] is an auto gain ranging amplifier

[24] is a final indication (driving) signal

[25] is a monitoring and alerting indicator

[27] is a tighten rubber

[28] is a coaxial cable

[29, 36] is a human body

[30] is a transmitter assembly

[33] is an insulator housing

[34] is an electromagnetic field

[35] is a patient's heart

[37] is a baby's bed or incubator

[41] is a landscape area under security protection

[43] is a security device

[46] is a sliding door

[48] is corridor walls

[49] is a is a liquid flow transducer assembly

[50] is a non metallic tube
[51] is an inspected liquid
[54] is an insulated and shielded transmitting wire
[55] is an area under inspection / corridor
[56] is a RF tank under inside the bi-directional coupler
[57] is a circuit for achieving a symmetry bi-directional coupler
[58] is a negative DC voltage generator
[59] is a Velcro type (hook and loop) binding
[60, 61] are RF form **VF** and **VR** signals
[62, 63] are DC blocking (AC coupling) capacitors
[64, 65] are rectifying diodes
[66, 67] are the demodulated signals
[68, 73, 74, 77] are RF suppression chokes
[69, 70] are the demodulating (integrating) capacitors
[71] is a difference amplifier
[72] is an O/P of difference amplifier
[75, 76] are integrating resistors

The device structure according to the invention, for all the applications aforementioned, has generally the same configuration. The slight difference in specification between each individual application is due to the difference in the requirements from one application to another. These differences will be explained in the related sections.

Referring to the drawings and more particularly to **fig. 1**, the first part of the device is the generator of the electromagnetic waves (EMW). This is a RF transmitter **1** with a power level from a fraction of one watt to few watts. The power has to be minimized for more safety in case of applications related to the human body such as in a cardiograph (**fig. 3**), and for newborn babies (**fig. 4**). This is also applicable in cases where there is a need for the use of non-standard frequencies, which are not permitted. The frequency of the RF transmitter **1** should be tuned to match as near as possible the resonance frequency of the targeted objects **9**, **35**. In general, utilization of the standard permitted

frequencies; eg: **27.12MHz** in such applications are adequate and satisfy the requirements.

The generated RF energy passes through a bi-directional coupler **2**, which detects and identifies the actual values for the **V_F 10** and **V_R 11** signals. Then the RF energy is directed to the matching network or more precisely to what is so called antenna tuner **3**. The function of the antenna tuner is to convert the complex parasitic impedance of the load (media) structures (i.e. human body **29**, **36**, tree trunk **8** etc) into a real impedance value, and to match, as closely as possible, the output impedance of the RF transmitter **1**.

In certain applications the need of high-speed automatic type antenna tuners is essential in comparison with manual or semi-automated tuners. The applications which require the use of a high-speed antenna tuner with a tuning time of a few seconds or less are those in which the time is limited. For example, in heart monitoring **(fig. 3)** it is necessary to minimize the device preset time as the full process of cardiograph monitoring is executed within the time frame occurring between breath cycles. This is to isolate the heart activity from lung motion, so as to obtain a few full cycles of the heart's activity in between the volitional breath pauses. Additionally the device can be tuned to identify the heart movement in isolation to the lung activity by narrowing the time response band width. This is because lung activity is much slower than heart movement, where the patient can voluntarily slowdown or even can stop his breathing process for a few seconds.

Using an antenna tuner of the so-called un-balanced output type enables the use of a single wire transmission line. This line is connected to a single conductive rigid or flexible metal plate, which can have any geometric form or size. A metallic grille, grid, rod or just a wire may be used in place of the metal plates, to function as a transmitting antenna. In a few applications the transmitting antenna, wherever possible, should encircle the load media, for example a tree trunk **8** when the device is intended to detect the infestation by pests **9**.

When a balanced output type antenna tuner **3** is used, or when an un-balanced type antenna tuner is connected to the output of the unbalanced to balanced transformer **5** (**fig. 3**), this will enable the use of dual transmitting lines **4** together with dual-transmitting antenna **6, 31** & **32** etc. so as to narrow the detecting and monitoring area. Each of the antennas could have the same configuration described aforementioned. Then, using adjacent, opposite or encircling dual-transmitting antenna **6, 31** & **32** etc. on the targeted load **8, 29, 36**, sensitivity will be increased. This will result in the narrowing and direction of the EM field **34** (**fig. 3**) to cover most of the targeted area.

The V_F **10** and V_R **11** output signals, produced by the bi-directional coupler **2**, pass through a so-called a high pass filter (HPF) consisting in its simplest form, of an AC coupling (DC blocking) capacitor **12**, **13** in series, with a resistor **14, 15** in parallel. This will pass only the required Variable V_F **17** and V_R **18** signals (**fig. 1** & **9**), which has the indication for any movement in the load (media).

Variable V_F **17** and V_R **18** signals then pass to the analog equation processor unit **19**, which then uses the preferred arithmetic equation (formula) to combine the V_F **17** and V_R **18** signals. This then produces a signal V_E **20**, where $V_E = F(V_F, V_R)$. As an example and not by way of limitation, equations such as **VSWR** or the reflection coefficient etc, can be achieved by the use of analog circuits.

The analog equation for the **VSWR**: V_E = **VSWR** = $(V_F+V_R) / (V_F-V_R)$ can be achieved by using an analog summing amplifier to function as its nominator (V_F+V_R), and an analog difference amplifier to function as its denominator (V_F-V_R). Then the value of **VSWR** is achieved by dividing the resultant values for the nominator by the denominator. The division can be carried out by the use of analog logarithmic and anti-logarithmic circuits, or by using ready made analog dividing integrated circuits. For example the analog divider integrated circuit (IC) AD538 made by Analog Device Inc, or similar ICs made by others, are suitable. In similar ways it is easy to utilize the analog circuits to realize the equation for the reflection coefficient:

$V_E = \rho = (V_R/V_F)$, or its opposite value $1/\rho = (V_F/V_R)$.

Selection of any one from the given equations is dependent upon the final design requirements. Utilising the **VSWR** equation gives more stability over a wide range of noise and drifts etc, which are produced in the RF transmitter **1**. Where such noise effects will modulate the RF EMW. Such modulation theoretically will not result in any change in the **VSWR** value.

Normally due to the use of large number of components to achieve such equation circuit, the resulting internal components noise is added to the requested useful signal. Therefore the use of the **VSWR** formula is preferable in applications such as the access controls **(fig. 7),** and cardiography **(fig. 3)**, wherein the size of the targeted object **35** is relatively large and high stability and low gain (a few thousands) is desired.

When the **VSWR** equation is used, V_F **10** and V_R **11** signals should pass directly to the equation processor unit **19**, this eliminates the need for the HPF **12**, **13**, **14**, **15** in the input circuit, and the HPF should be located at the output of the equation processor. This configuration can be applied also to any dividing equation.

Other equations like (V_F/V_R) or (V_R/V_F) dramatically improve the device's performance, because they use fewer components in comparison to the **VSWR** equation, so give improved results and stability over a wider range of conditions.

Analog circuits also can achieve the non-standard and useful equations such as (V_F-V_R) or (V_R-V_F). These subtractive equations enhance the performance over a wide range of conditions. This is due to the use of a so-called difference or instrumentation type amplifier (IA). An IA, which has a very high common mode rejection ratio (CMRR), enables operation in noisy environments. Various IA ICs, which have ultra low internal noise of about 1nv are available and are produced widely by many manufacturers, such as IA IC. INA103 made by BURR BROUN Inc.

Satisfactory results can be achieved by using only one of the **V_F 17** or **V_R 18** signals, especially where an application does not require a very high gain, or if high quality and less noisy components are utilized in a perfect design, and if the system is used in a low interference and ambient noise environment.

Practical observation has shown that the variable components **17, 18** of the **V_F 10** and **V_R 11** voltages, which are generated by the moving objects inside the load (media), have an approximately symmetric non-proportional relationship. This is especially achieved when a good degree of match is reached. This means that when the **V_F 17** signal increases the **V_R 18** signal decreases and vice versa, a combined differential signal occurs.

This conclusion represents the variable components of the **V_F 10** and **V_R 11** as a source of differential signal. This highly improves the use of subtracting equations (**V_F-V_R**) or (**V_R-V_F**). Where IA can perfectly achieve such equations, this type of amplifier is specially designed to work with the differential type signal to provide a higher performance over a wide range of unstable ambient conditions.

Normally when a good degree of match is reached, the final **V_F 10** signal becomes greatly larger than the **V_R 11** signal. This reduces the symmetry between the variable **V_F 17** and **V_R 18** signals. This happens due to the different working (saturation) points at the non-linear (exponential) volt-ampère characteristic (VAC) of the rectifying diodes, normally these diodes contained in the bi-directional coupler **2**, which is used to detect the **V_F 10** and **V_R 11** signals in the RF tank **56 (fig. 9)**.

The use of a so-called active diode, where the diode is fixed in the feedback circuit of an operational amplifier, will help, but it is still not enough, as such high frequency operational amplifiers generally produce a relatively high level of internal noise.

Still there is a need to find other effective ways to deal with this problem. An excellent alternative way **(fig. 9)** can be achieved by shifting down the positive voltage level of the RF signal **61** before it reaches the rectifying diode **65** of the **VF** detection circuit. In this way both diodes **64, 65** will work in the same working (saturation) point at the VAC. This can be achieved by applying a negative DC voltage **56** at the **VF** diode anode **65**. This equalizes the rectified DC voltages **66, 67** at the cathode of both diodes **64, 65**. This will not affect the requested variable signal **17, 18**, as these signals are so small, and in the worst case they are greatly smaller than the RF form **VF 61** and **VR 60** signal, so in this way symmetry is achieved.

The **VE 20** signal generated in the equation processor unit **19** as a function of **VF 17** and **VR 18**, in accordance to the required and used equation, is then ready for the following processing steps.

The **VE 20** signal needs to be amplified to that level where the analyzing and monitoring can be executed. In addition to the amplification, filtration will be required.

The **VE 20** signal then passes to the amplifier circuits **21**, **23**, which contain multi-amplifier stages. In the preamplifier first stage circuit **21**, the signal should have an acceptable gain level (a few hundred times). Then the main gain can be obtained by manual adjustment or by an auto gain ranging amplifier **23**. The total gain range for the amplifier should cover all the possible signal amplitude variations. This occurs due to the different sizes and positions of the inspected media or objects.

Signal filtration is a major part of the amplifier circuits **21**, **23**, which generally helps in minimizing the noise and interference which may reach the device circuits. The signal filtration is achieved by the introduction of passive and active wide band pass and notch filters wherever possible in the various stages of the device. The filter bandwidth is defined according to the expected motion speed of the tracked targeted object **9**, **35** etc.

The final stage **25** will be the provision of audio or visual indications of the monitored subject. This can include a hardcopy of the observation results if required. Additionally as an example, visual indications can be complimented by the use of a buzzer with different tones or light emitting diode (LED) paragraph to show the level of infestation by red palm weevil **9**. This can be achieved by averaging the signal peaks for one insect in a defined period of time, then by counting the number of peaks within the same time interval. The combinations of manner of indicating the presence of the pest are manifold. Additionally the resulting (indication) signal **24** can be used for analytical purposes in applications which require such analysis.

Device sensitivity can be changed by adjusting the amplifier **23** gain, or by shifting the response level threshold. This detection circuit for the response threshold may be located in or before the final stage **25**, where it is used to drive a variety of types of indicators, such as for triggering the alarm circuits.

Finally it is essential that special care to be taken in fabrication and operation of the device in the real world. The device must be well screened and shielded,. This is to minimize the external electromagnetic interference or noise effects. These noise effects could originate from the air currents flowing inside the device. The assembly design should include a metallic separation partition in between the linear and the RF circuits.

Additionally the RF ground **7** and the linear circuit's ground **16** should be well RF isolated. This can be achieved by joining both grounds through a suitable RF inductive suppression choke **68, 73, 74, 77** at a value range of a few milli-Henry.
Extra care should be taken to ensure that the operator is sufficiently remote from the detection area to be sure that there is no possibility of undue interference. This can be achieved by separating the device into two individual parts. One can include the circuits up to the preamplifier **21**, the other to include the all-remaining circuits, which will be directly used by the operator. This is to allow the

operator to do the necessary tuning and adjustments. The link **22** between the two units should be sufficiently long and should utilize good shielded cable.

When the device is used in the open field; eg: to detect tree infestation (**fig. 2)** by borer pests **9** hidden inside the tree trunk **8** or the upper roots, the total surface area of the transmitting antenna **26** should be minimized so as to eliminate the wind effect which could vibrate the antennas. Any vibration could generate an interference signal. To solve this, rubber **27** or "Velcro" (RTM) type bindings **59** can be used to tighten the transmitting parallel wires **26** or springs onto the tree trunk **8**.

Wherever it is considered necessary to have an extended transmission line, and where the use of dual transmitting antennas is preferable, this can be achieved by utilising the unbalanced type antenna tuner through connecting to un-balanced to balanced transformer **5** (**fig. 2** to **7**). This will enable the length of the transmission line to be extended by the use of high quality RF coaxial cable **28**.

The surfaces area of the transmitting lines or the antennas have to be electrically well insulated by the use of proper insulation **33** (**fig. 3**), such as rubber, PVC...etc. especially when the working media contains a high volume of moisture, or in case of applications related to human bodies.

In security applications (**fig 5** and **6**) as an example, the transmitted RF energy can be modulated with a medium range frequency (few kHz), to disable the possibility of any interference caused by intruders. Such modulation will require narrow band pass filters of the same modulating frequency in the preamplifier input circuits.

CLAIMS

1. Apparatus for non-invasively detecting movement of object(s) and/or fluid flow in a body, said apparatus comprising:-

radio frequency (RF) transmitter means for generating RF radiation;

at least one RF antenna for directing RF radiation generated by the said transmitter means to the body being monitored;

antenna tuner means for matching the output impedance of the said transmitter means with the load impedance of the said body;

processor means for processing forward and reflected RF radiation signals from said transmitter to provide an output signal representative of changes to the said load impedance, whereby to indicate movement of at least one object or fluid flow in the said body.

2. A method of non-invasively detecting movement of object(s) and/or fluid flow in a body; said method comprising the steps of:-

directing radio frequency (RF) radiation to the body being monitored by RF transmitter means;

matching the output impedance of the said transmitter means with the load impedance of the said body;

processing forward and reflected RF radiation signals from the said transmitter means to provide an output signal representative of changes to the said load impedance, whereby to indicate movement of at least one object or fluid flow in the said body.

3. A device comprising:

a radio frequency (RF) transmitter for generating electromagnetic radiation for detecting and/or monitoring moving object(s) and/or fluid flow in concealed media, the said transmitter having a power range from 0.1 to 50 watts;

means for selecting a RF transmitter frequency to substantially match the resonance frequency of the object(s) or fluid being monitored, the said frequency being in the range of 1 to 1000 MHz;

at least one antenna comprising metal sheets or wires, the said antenna being adapted for location in the region of the media containing the object to be monitored; an antenna tuner means having an impedance matching means for matching the output impedance of the RF transmitter with the equivalent impedance of the inspected media;

means for processing forward and/or the reflected antenna transmission line voltages to provide a single voltage signal;

means for extracting variable signals from the forward and/or reflected voltages to generate an indicating signal which provides an indication of movement of the targeted object or fluid flow within the concealed media;

band pass filter means for filtering the indication signals to limit the variation range to cover only an expected motion of the targeted object(s) or fluid flow;

amplifying means for amplifying the indication signal to a level that can drive an indicator circuit.

4. A device as claimed in Claim 3 wherein said single voltage signal comprises the voltage standing wave ratio (**VSWR**) of the forward voltage (V_F) and reflected voltage (V_R) signals, where **VSWR** = $(V_F+V_R) / (V_F - V_R)$.

5. A device as claimed in Claim 3 wherein said single voltage signal comprises the reflection co-efficient ρ of the forward voltage (V_F) and reflected voltage (V_R) signals, where $\rho = (V_R/V_F)$

6. A device as claimed in Claim 3 wherein said device is adapted for detection of early infestation by stem borers or red palm weevils or other pests in all types of trees, hidden deeply within the tree trunks or upper roots.

7. A device as claimed in Claim 3 wherein said device is adapted for monitoring human heart motions.

8. A device as claimed in Claim 3 wherein said device is adapted for early detection of sudden death threat in premature or newborn babies.

9. A device as claimed in Claim 3 wherein said device is adapted for direct sensing of sudden fluctuation in the flow of liquids

10. A device as claimed in Claim 3 wherein said device is adapted for use in concealed security systems.

11. A device as claimed in Claim 3 wherein said device is adapted for the use in automatic access control.

12. A method for detecting and/or monitoring moving objects or fluid flow in concealed media by detecting high frequency impedance variations of the inspected media at a fixed Radio Frequency (RF) by means of a monitoring device; said method comprising:

surrounding the inspected media with a field of high frequency electromagnetic radiation through at least one transmitting antenna comprising metallic sheets or wires and having a power of 0.1 to 50 Watts;

matching the output impedance of the said monitoring device; and the equivalent complex impedance of the inspected media;

selecting the frequency of the electromagnetic radiation (RF) to closely match the resonance frequency of the targeted moving object or fluid, in the range of 1 to 1000 MHz;

extracting variable voltages from forward and reflected voltages of an antenna transmission line;

processing the extracted variable voltages, to produce a signal, which indicates movement of the targeted object or fluid within the concealed media.

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10

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0605847 A1 (MOTOROLA) Whole document	1,2, 3, 12 at least
X	EP 0515187 A2 (WOLFF) Whole document	1,2, 3, 12 at least
X	WO 96/41134 A2 (WOLFF) Near field embodiment.	1,2, 3, 12 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		